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A MULTIVARIATE ANALYSIS OF ANNUAL EARNINGS FORECASTS GENERATED FROM QUARTERLY FORECASTS OF FINANCIAL ANALYSTS AND UNIVARIATE TIME SERIES MODELS

William S. Hopwood, Assistant Professor, Dept. of Accountancy
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#561

College of Commerce and Business Administration
University of Illinois at Urbana-Champaign

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SUMMARY:

The study compares the forecast accuracy of financial analysts, ARIMA models, and various permier models considered in the literature in the predicting of annual earnings per share. Various refinements were made of previously used methodologies. The results of the multivariate analysis indicated that financial analysts provide the most accurate forecasts. In addition, the divergence in accuracy between the various sources of forecasts tend to decrease as the end of the year approaches, while at the same time there is a general increase in accuracy. Also specific results are provided for individual model performance.

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A Multivariate Analysis of Annual Earnings Forecasts Generated from Quarterly Forecasts of Financial Analysts and Univariate Time Series Models

There is a widespread belief that the use of forecasted accounting earnings as a measure of expected earnings power is of primary importance in investment decisions. The Financial Accounting Standards Board [1977] recently reinforced this belief in their conceptual framework project. A major question, however, exists as to the most appropriate source of these forecasts. Current sources widely available are financial analysts and univariate time series models. Policy making boards, such as the SEC and the FASB, are considering whether these sources are adequate or whether management also should be required to forecast accounting earnings. Since empirical researchers that have investigated aspects of investment decisions, such as cost of capital, firm valuation, and the relationships between earnings and stock prices, have utilized forecasted accounting earnings as their measure of earnings expectations, they also should be concerned with an evaluation of forecast sources.

Because of the difficulties of specifying a complete operational relationship between the forecast source and the investment decision, including a loss function, previous research that attempted to evaluate the competing sources of forecast information generally has focused on a stated or implied purpose of these forecasts. The purpose considered in this paper is the ability to predict annual earnings from quarterly forecasts. This purpose has been suggested in the discussion memorandum, Interim Financial Accounting and Reporting (FASB [1978]); it also has been the subject of previous research.[1] Most of these related

research studies did not incorporate the more sophisticated time series analysis currently available. The more current study by Lorek [1979] compared the predictive ability of four univariate time series models as well as certain more naive models; his comparison, however, did not include financial analysts.

In addition, these studies generally utilized univariate statistical methods when the multiple model and multiple time period factors indicated that a multivariate hypothesis was being considered. Several problems are raised by the use of univariate methods. First, the univariate approach to the research issue necessitates a larger number of tests of the null hypothesis rather than a single multivariate test. Since each individual test has an associated alpha error, there is a greater possibility that a number of these tests will reject the null hypothesis purely by chance. An additional problem relates to the assumption that univariate tests conducted at multiple time periods on the forecasted earnings for the same firms are independent. Since earnings variables for the same firm usually are highly correlated, the univariate tests may not be independent. These problems of combined reliability and statistical dependence may have affected the empirical findings and the resultant conclusions.

The present study considers these problems while providing a comparison of the relative accuracy of annual earnings forecasts generated from the quarterly forecasts of financial analysts and the four univariate time series models evaluated by Lorek [1979]. This comparison, however, is provided based on a multivariate analysis of variance design (MANOVA). The MANOVA was chosen, because, as a multivariate test,

it provides the advantage of overcoming the problems of combined reliability and statistical dependence. Finally the multivariate procedure is very powerful (Cooly and Lohnes, 1971, p. 228) and as used in the present study is virtually distribution free. The MANOVA model is described in detail in a subsequent section.

In addition, the univariate models were reidentified and reestimated as each earnings figure in the test period was announced. Unlike most previous studies, then, this study utilized all earnings data that was available at the time a forecast was generated. This is considered potentially very important because comparing two models based on forecast errors when one model is based on more up to date information might produce a bias in favor of the more up to date model.

Finally the present study differs from previous research in that the parametric testing allows a consideration of the magnitude of the data in testing. This provides for information not available via the rise of non-parametric ranking procedures. In fact, forecast methods might be identical in their average ranking of forecast errors but quite different with respect to their simple means.

The paper is organized into four major sections. An analysis of the methodologies and results relating to prior research in the area is presented first in order to provide justification for the models chosen in the present study. The research design and statistical tests utilized in the present study then are presented followed by the empirical results. A summary of these results and the conclusions obtained complete the presentation.

PREVIOUS RESEARCH RESULTS

Univariate Models

The four univariate models are generated utilizing the time series process suggested by Box and Jenkins [1970].[2] The complete process is a statistical technique that is used to (a) identify, in a parsimonious manner, the most appropriate model consistent with the apparent underlying process that generated the observed time service data; (b) estimate the parameter values for that particular model; and (c) perform diagnostic tests. The process consists of an iterative approach that excludes inappropriate models until the model and its parameter values that best fit the data are selected. Compared to previous time series analyses that were characterized by the individual consideration of many possible models, the Box and Jenkins process permits consideration of a much greater number of models in a more structured approach.

The first univariate model employed in this study, hereafter designated the BJ model, is a model individually identified and its parameter values estimated for each firm in the study. Thus, the BJ model for each firm is determined from the complete Box and Jenkins process. Since the model is determined from the consideration of a broad generalized model inclusive of all possible combinations of autoregressive and moving average models, the initial expectation might be that forecasts generated from an individually fitted model should be more accurate than forecasts generated from a model that was generally identified for all firms. However, the identification process is both subjective and costly. In addition, the identification of a model from a finite series of data points may not result in the model consistent with the underlying process generating an infinite series.

Because of these factors and observed empirical results, it has been suggested that a generally identified or premier model, with individual firm estimation of parameter values may generate forecasts that are equal or superior to those generated by the BJ model. If a single model form generates results that are comparable to an individually identified model, it would obviate the need to perform the subjective and costly identification process required for the latter model. It also would diminish the problem associated with the identification of a model from a finite series of observations.

The models that previously have been proposed are (1) a consecutively and seasonally differenced first order moving average and seasonal moving average model (Griffin [1977] and Watts [1975]), (2) a seasonally differenced first order autoregressive model with a constant drift term (Foster [1977]), and (3) a seasonally differenced first order autoregressive and seasonal moving average model (Brown and Rozeff [1978]). In the notation used by Box and Jenkins, these models are designated as (0,1,1) X (0,1,1), (1,0,0) X (0,1,0) and (1,0,0) X (0,1,1), respectively. In this study, they are referred to as the GW, F and BR models.[3] The models are generally identified for all firms with individual firm estimation of the parameter values. Thus, only the parameter estimation portion of the complete Box and Jenkins process is used.

The different forms of a single or premier model form have been suggested based on the diagnostic tests incorporated in the Box and Jenkins process and also on predictive evidence. Watts, who initially suggested a premier model, based this suggestion on evidence that the average cross-sectional autocorrelation function (acf) could be modeled

by the (0,1,1) X (0,1,1) model. Griffin also demonstrated that the average acf could be modeled by the (0,1,1) X (0,1,1) model. His suggestion also was prompted by the consistency of the distribution of the Box-Pierce statistic with the existence of white noise residuals. Foster based his suggested model primarily on the evidence that one-quarter ahead absolute percentage errors associated with the F model were lower than these errors generated by the BJ model. However, Brown and Rozeff, Griffin, and Foster himself, note that the F model does not fit the data in that the model fails to incorporate a systematic seasonal lag. Based on the Foster research, Brown and Rozeff proposed a model that incorporated a seasonal moving average component and concluded that their model performed favorably against the BJ, F and GW models over several forecast horizons. Most recently, Lorek [1979] extended this comparison among these four univariate models by analyzing their relative ability to predict annual earnings generated from quarterly forecasts. His results indicated that as fewer quarterly forecasts were included in the annual forecast, the univariate time series models performed better than more simplistic models. However, based on the inconsistency of his results and the previous studies by Brown and Rozeff, Foster, Griffin, and Watts, he concluded that it may be premature to conclude that a single premier model is best for quarterly earnings. Thus, the forecast accuracy comparison of the individually identified and the suggested premier models remains an unanswered question.

Financial Analysts Model

In addition to the four univariate model forecasts, the study included forecasts generated by financial analysts. The univariate

models can be criticized in that they neglect additional publicly available information that may be potentially useful; financial analysts are not subject to this criticism. Rather, financial analysts have been criticized in that their analysis process may be too detailed and the additional cost incurred may not be justified.

Empirical results that support these assertions were provided by Cragg and Malkiel [1969] and Elton and Gruber [1972]. Both studies concluded that analysts' forecasts were not more accurate than forecasts based on earnings streams alone. The study by Brown and Rozeff [1978], on the other hand, led to the conclusion that financial analysts' forecasts were superior to forecasts generated solely from earnings data. These results, however, have been questioned by Abdel-khalik and Thompson [1977-78] as being overstated due to their temporal nature. The empirical results, therefore, are inconclusive. In addition, the relative accuracy of annual earnings forecasts generated from the analysts' quarterly forecasts has not been compared with similar forecasts from the BJ, BR, F and GW models.

In the present study, these univariate models were included in order to assess the relative accuracy of these forecasts. Relative accuracy then may be useful in determining the existence of a premier model. The results of the univariate models in comparison to the financial analysts may be used to provide evidence as to whether the additional cost incurred by financial analysts is justified. This evidence provided as to the relative accuracy of forecasts generated from earnings data alone and earnings data plus other variables also may provide useful information to the SEC and the FASB as to the desirability of management forecast disclosure.

RESEARCH DESIGN

General Hypothesis

The preceding sections highlight the recent attention given to the question of whether a single generally applied univariate model provides equal or superior forecasting results than an individual firm identified model. An additional question is whether a univariate model provides equal or superior forecasting results to those of a model that incorporates more potentially useful information. These questions are incorporated in the following null and alternative hypothesis.

Hypothesis:

Ho: There is no difference in the forecast error generated by each of five models (BJ, BR, F, FA and GW).

Ha: There is a difference in the forecast error generated by each of five models (BJ, BR, F, FA and GW).

Two forecast error metrics were calculated.[4] The first metric was the mean absolute percentage forecast error (MAPFE) which is specified as:

$$\frac{|A_{it} - P_{itn}|}{|A_{it}|}$$

where A_{it} = actual earnings per share for firm i in quarter t,

P_{itn} = predicted earnings per share for firm i in quarter t, generated by model n

This metric was selected because it is a measure that establishes relative comparability of forecast errors between firms that produce earnings per share that are different in absolute scale. Since equal

weight is assigned to all forecast errors it assumes a linear loss function. However, because of the possibility that outliers might not be best represented by a linear loss function, an outlier adjusted mean absolute percentage forecast error metric (OAMAPFE) also was utilized. This adjustment consisted of assigning the value of 3.0 to all forecast errors that had a value greater than 3.0.[5] The resultant error metric then assumed a linear loss function that was truncated for outliers.

The Multivariate Design

The test of the null hypothesis was based on a multivariate analysis of variance design (MANOVA). MANOVA is a simple generalization of analysis of variance (ANOVA). The primary difference is that ANOVA tests for differences between means for a single variable where MANOVA tests for difference between means for a group (vector) of variables.

The basic design used in the present study is that of orthogonal polynomial analysis of doubly multivariate data as described in Bock (1975, Ch. 7). The approach is one of converting a univariate repeated measure design into a MANOVA design.[6] In terms of the present research, it would be possible to consider the forecast model, the quarter from which the forecast is made, and the year of the forecasts as repeated measure factors. However this would require the necessity of making highly restrictive assumptions with respect to the distribution of the data.[7] The orthogonal polynomial MANOVA eliminates the need to make these assumptions. In fact the only assumption needed in the present study is that of multivariate normality and this has been proven to be

satisfied for sufficiently large samples, via the multivariate central limit theorem [Anderson, 1958; Harris, 1975, p. 232; Ito, 1969]. (The sample in this research is based on annual forecasts originating in each of the 20 quarters during the 5 year test period for 50 firms giving 1000 origin dates for each model.) Also, there is typically a need to make an assumption of equality of subgroup covariance matrices, but this is not necessary in the present study since the tests involve only one sample and therefore do not depend on pooling of covariance matrices.

Sample of Firms

The sample of 50 firms (Appendix) were selected randomly from 205 calendar year-end firms whose reported quarterly earnings data was available from 1951 through 1974. These observations were obtained from The Value Line Investment Survey and the Compustat file.

The analysts' forecasts also were obtained from The Value Line Investment Survey. Twenty annual forecasts were obtained commencing with the first quarter of 1970. Each annual forecast was obtained by summing the forecasts for the remaining quarters of the year and the actual earnings of previous quarters. Thus, the annual earnings forecast generated in the second quarter consisted of three quarterly forecasts and one actual quarterly earnings figure.

The initial identification of the BJ models and the estimation of the parameter values of all four univariate time series models were derived from the earnings series, adjusted for stock splits and stock dividends, from 1951-1969. Forecasts subsequent to the forecast

originating with the first quarter of 1970 were obtained through a process of reidentifying the BJ model and reestimating the parameter values of all models. Therefore, the minimum number of observations used for identification and estimation was 76 observations; the maximum was 95. This forecasting method, based on a reidentification and reestimation process, conducted for each forecast time origin, was included to provide a more relevant comparison between the univariate models and the financial analysts. The analysts consider information that is currently available when they make their forecast; the univariate models, therefore, should include the most current earnings information that is available when their forecasts are generated. McKeown and Lorek [1978] have demonstrated that this rationale is supported empirically. Their results indicate that univariate model forecasts are improved when more recent observations are included through a reidentification and reestimation process.

EMPIRICAL RESULTS

Forecast Accuracy

A comparison of the means and distributions of both error metrics is contained in Table 2. Inspection of these measures indicated that, when the error metric was not adjusted for outliers, the means and standard deviations of the forecast errors generated by the financial analysts were lower than those generated by each of the four univariate models. The best performing univariate model was the premier model suggested by Brown and Rozeff followed by the model individually identified for each firm. The relative ranking of the FA, BR and BJ models

TABLE 2

Rank Comparisons of Means and Distributions of Error Metrics by Model and Quarter in Which The Annual EPS Forecast Originated

	Error Metric					
	MAPFE			OAMAPFE		
Quarter	Model	Mean	Standard Deviation	Model	Mean	Standard Deviation
First	FA	.3414	.6817	FA	.3171	.5307
	BR	.5133	2.8921	BR	.3286	.4658
	BJ	.5217	3.0359	BJ	.3326	.4771
	F	.6489	4.4476	GW	.3498	.5115
	GW	.6998	5.1043	F	.3527	.5227
Second	FA	.2806	.6015	GW	.2612	.4550
	BR	.4009	2.2906	FA	.2651	.4762
	BJ	.4257	2.6690	BR	.2639	.4439
	F	.5035	3.4166	BJ	.2670	.4027
	GW	.5469	4.5089	F	.2830	.4609
Third	FA	.2184	.7336	GW	.1806	.3907
	BR	.2707	1.4994	FA	.1848	.3752
	BJ	.3312	2.3151	BR	.1872	.3770
	GW	.3373	2.6424	BJ	.1955	.3801
	F	.3766	2.7328	F	.2123	.4362
Fourth	FA	.1003	.2804	FA	.0970	.2372
	BR	.1538	.8742	BR	.1085	.3034
	BJ	.1629	.9525	GW	.1094	.3208
	GW	.1776	1.2296	BJ	.1126	.3036
	F	.2318	2.0004	F	.1156	.3060

held for the annual forecasts generated during each of the four quarters. The F model performed better than the GW model in the earlier two quarters; this relationship changed in the third and fourth quarters. The range in performance between the five models varied from approximately 36 percent when the annual forecast included four quarterly forecasts to 13 percent when only one quarterly forecast was included in the annual forecast.

When the error metric was adjusted for outliers, the range in performance between models decreased to a maximum of 3.6 percent in the first quarter's annual forecast. The relative mean accuracy of the FA, BR, BJ and F models remained consistent from quarter to quarter; the performance of the GW model varied widely. It was the worst performing model in the first quarter and the best performing model in the second and third quarter annual forecasts. With the exception of the GW model then, there was a consistency of relative performance for both error metrics.

The differences in the means and variances between the two error metrics were attributable to a small number of outliers. A list of these outliers is contained in Table 3.

Analysis of the list of outliers by model indicated that the financial analysts generated fewer outliers than the univariate models. In addition, the largest outlier generated by the financial analysts was 10.08 which was much lower in magnitude than the largest outlier generated by any of the univariate models. It also is interesting to note that 16 of the 18 outliers greater than 10.0 generated by the univariate models were accounted for by the earnings forecasts for the same firm

TABLE 3

List of Outliers > 3.0 By Model,
Firm, Year and Quarter

Model	Firm	Year	Quarter			
			First	Second	Third	Fourth
FA	4	74	3.62			
	44	71	5.17	5.42	10.08	
	48	74	5.77	4.97	4.32	3.84
BJ	31	71	4.69			
	44	71	47.62	42.02	36.36	14.38
	48	74	3.97	3.65	3.55	4.21
BR	31	71	6.48	3.13		
	44	71	45.17	35.75	23.21	13.04
	48	74	3.53	4.37	3.67	4.26
GW	4	74	5.85	3.90	3.12	
	31	71	10.48	4.61		
	44	71	79.97	71.09	41.54	18.87
	48	74	3.17	3.83	3.51	4.18
F	4	74	3.49	3.52	3.21	
	31	71	9.31	6.03	3.95	
	44	71	69.69	53.56	42.86	31.43
	48	74	3.55	4.03	3.06	3.61

during the same year. A summary of the number of outliers generated by quarter for each of the five models is contained in Table 4. This Table indicated that more outliers occurred in the annual forecasts originated in the first quarter and that the total number of outliers greater than 3.0 amounted to approximately 1.08% of the total number of 5000 forecasts.

TABLE 4

Number of Outliers > 3.0 By Model and Quarter of Annual Forecast Origin

	Quarter				
Model	First	Second	Third	Fourth	Total
FA	3	2	2	1	8
BJ	3	2	3	1	9
BR	3	3	2	2	10
GW	4	4	3	2	13
F	4	4	4	2	14
Total	17	15	13	9	54

For both error metrics, the results in Table 2 also indicated that, during successive quarters, as fewer quarterly forecasts were included in the annual forecasts, the mean accuracy of all five models improved. These trends are illustrated graphically in Figures 1 and 2. In addition, these figures indicated an interaction effect between models and quarters in that the distance between models varied from quarter to quarter. Note that the advantage of the FA over the statistical models tends to decrease as the end of the year is approached.

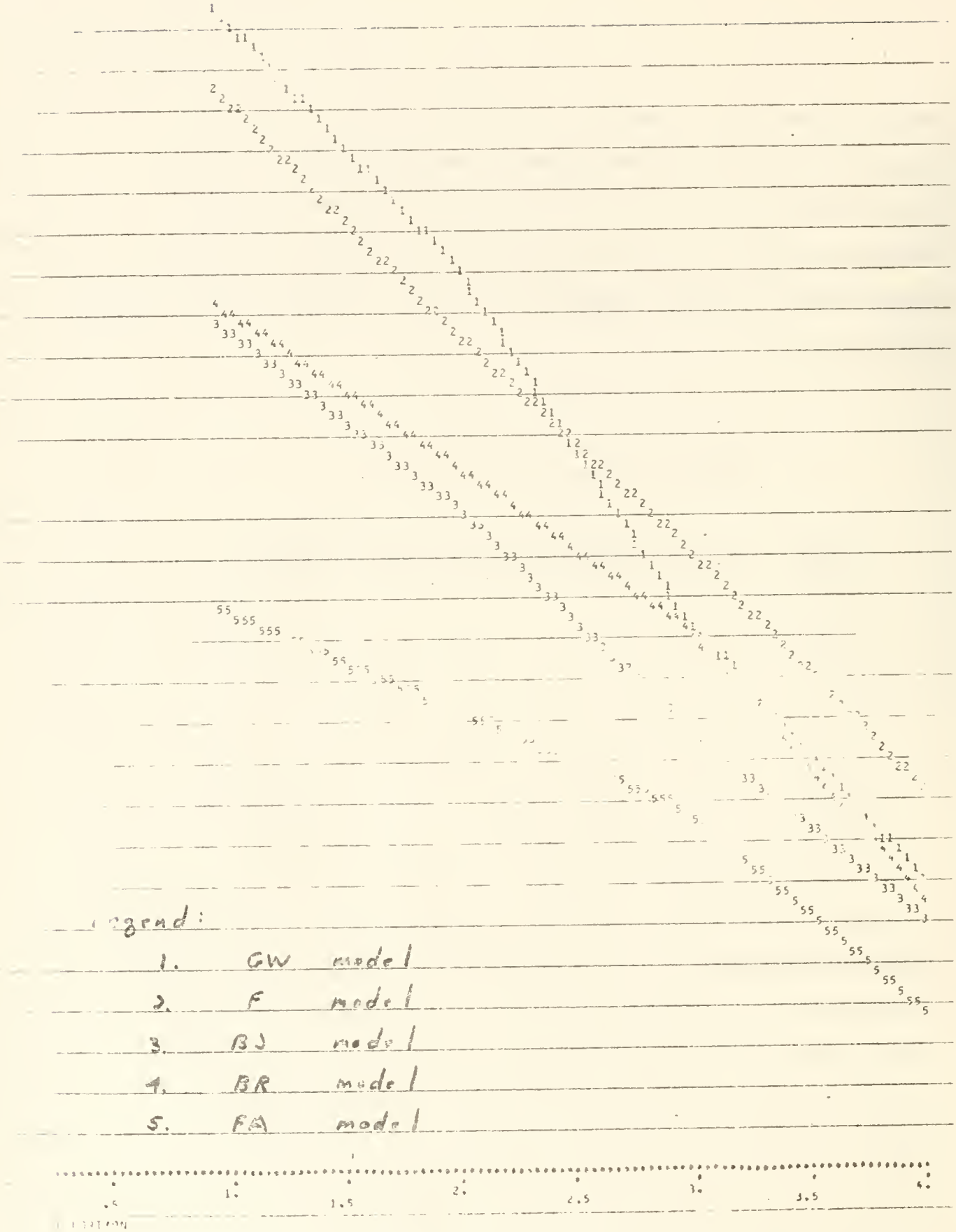
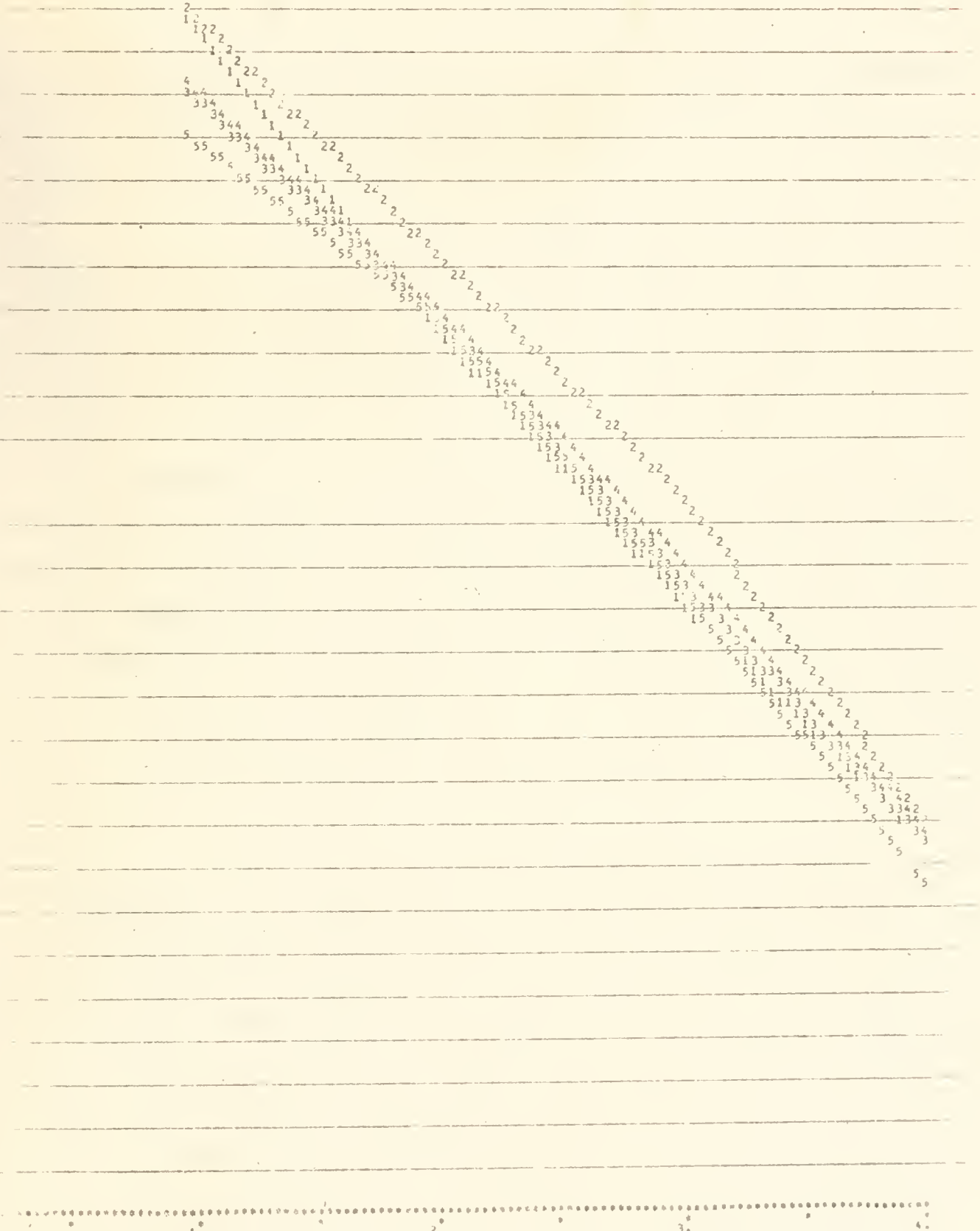

Legend:
1. GW model
2. F model
3. BJ model
4. BR model
5. FA model
.5
1.
1.5
2.
2.5
3.
3.5
4.

Figure
Graph of the Ratios Adjusted Mean Absolute Percen
Forecast Error Metric by Model and Quarter



Comprehensive Test

To test the null hypothesis that no difference in forecast accuracy existed, a MANOVA test was performed. The null hypothesis tested was:

$$H1: \quad \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \end{bmatrix}_{FA} = \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \end{bmatrix}_{BJ} = \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \end{bmatrix}_{BR} = \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \end{bmatrix}_{F} = \begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \end{bmatrix}_{GW}$$

where Q_i represented the annual forecast generated in the ith quarter. The probability that a higher F-ratio than the 2.49 obtained (d.f. = 16 and 34) was less than .0125 when the MAPFE was utilized as the error metric. The probability that a higher F-ratio than the 2.27 obtained when the outlier adjusted metric was utilized as less than .0218. There was sufficient evidence to reject the null hypothesis, thus supporting the alternative hypothesis that different forecast errors were generated.

Interaction Between Lead Time and Method

Since the profiles in figures 1 and 2 did not appear to be parallel, it was decided to test for interaction between the model and number of quarters ahead on the forecast horizon. This provides a test of the null hypothesis that the profiles in figures 1 and 2 are not parallel.

On the MAPFE metric, the test yielded an F-ratio of 1.5592 with a significance level of .1461 (given 12 and 38 degrees of freedom). On the outlier adjusted, metric, an F-ratio of 2.1135 with a significance level of .0398 (d.f. = 12, 38) was obtained. Taken together

these tests tend to indicate that there is an interaction between method and lead time.

Tests Between Specific Models

Since the results of the MANOVA test indicated that a statistically significant difference existed, more detailed tests were conducted. In order to determine which of the models differed in performance, vector comparisons of the equality of the forecast errors were tested between the financial analysts model and each of the univariate models. The results of these multivariate tests are contained in Table 5. Since the lowest probability exceeds 13 percent, these results indicated that there was insufficient evidence to reject the null hypothesis that no difference in forecast error accuracy existed between any of the vector comparisons for either of the error metrics.

TABLE 5

Results of the Multivariate Test
of Equality of Mean Vectors

Vector Comparison	Error Metric			
	MAPFE		OAMAPFE	
	F-ratio	P	F-ratio	P
FA vs BR	.51	.73	.56	.69
FA vs BJ	.54	.71	.97	.43
FA vs GW	1.73	.16	1.86	.13
FA vs F	.50	.73	1.73	.16

The non-significance of these specific tests indicates that rejection of H1 was largely due to the interaction effect. The net interpretation is that the relative forecasting accuracy of the 5 methods depends on the quarter in which the forecast is made.

Tests Between Specific Quarters

An additional null hypothesis tested was that no difference in annual forecast accuracy existed between the quarters in which the annual forecasts were generated. Since the probability of obtaining the F-ratio of 3.68 was less than .0184 when MAPFE was utilized and the probability of obtaining the F-ratio of 22.03 was less than .0001 when OAMAPFE was utilized, there was sufficient evidence to reject the null hypothesis for both error metrics. Thus, the alternative hypothesis that forecast accuracy differed from quarter to quarter was supported.

As evidenced in Figures 1 and 2, the means of the forecast error metrics decreased as the annual forecasts contained a smaller number of quarterly forecasts. A test for linear trend between quarters resulted in an F-ratio of 6.83 for the mean absolute percentage error and an F-ratio of 66.55 for the adjusted error metric. The probability of obtaining a higher value was less than .012 for the former and .0001 for the latter. The tests between quarters indicated then that not only did forecast accuracy differ between quarters, but that the accuracy significantly improved from annual forecast to annual forecast as the year progressed.

SUMMARY AND CONCLUSIONS

The results of this study must be considered in relation to certain limitations. First, noncalendar reporting firms, newly formed firms, and firms that went out of business systematically were excluded from the sample. The results also were conditioned on the use of two error metrics. Finally, the purpose considered in this paper was limited to the ability of the 5 models to predict annual earnings figures from forecasted quarterly figures.

These results indicated that when the use of univariate time series models was compared to the financial analysts model, the comparison favored the financial analysts. When the mean absolute percentage error metric was utilized, the financial analysts generated a mean error of .10 when only one quarterly forecast was included in the annual forecast. This error was 5 percentage points lower than the best performing univariate model. This difference increased to greater than 6, 12 and 17 percentage points as the annual forecasts included two, three and four quarterly forecasts. The standard deviation in each quarter also was lowest for the financial analysts. In addition, the financial analysts generated outliers greater than 3.0 that were lower both in number and degree than the univariate models.

When the error metric was adjusted for these outliers, the mean errors for the univariate models decreased by at least 18, 14, 9 and 5 percentage points respectively during successive quarters of the year. The mean error for the financial analysts, however, only decreased by 3, 2, 3 and 1 percentage points respectively. The range between the best performing and worst performing models decreased

therefore to a maximum of 4 percentage points. The FA models performed better than the BR, BJ and F models in all four quarters; the FA model, however, only performed better than the GW model in the first and fourth quarter.

Therefore the financial analysts tended to out-perform the statistical models on the adjusted metric with the exception of the GW model in the first 3 quarters.

Overall multivariate tests (for both error metrics) indicated the 5 methods, viewed simultaneously, are not equal with respect to forecast error. Significant tests and analysis of the profiles indicated that this overall difference is largely caused by an interaction between the quarter in which the annual forecast is made and the forecast method used. In particular the advantage of the FA over the statistical models tended to decrease as the end of the year approached.

The results further indicated that the premier model suggested by Brown and Rozeff performed better than an individually identified univariate model in each of the quarters for both of the error metrics. Thus, there was little justification for selecting the more subjectively and costlier determined individually estimated model. There also was little empirical support for the premier model considered by Foster. For both error metrics, this model consistently ranked as the poorest performing model. Additional evidence therefore was provided that quarterly earnings are characterized by both a regular and a seasonal component.

A further consideration is that the smallest mean absolute percentage forecast error generated in each of the four quarters exceeded 34,

28, 21 and 10 percent respectively as fewer quarterly forecasts were included in the annual forecast. With the outlier adjusted error metric, the smallest mean value in each quarter slightly decreased, but still exceeded 31, 26, 18 and 9 percent respectively. This may indicate that errors associated with annual forecasts may be so great, especially in the beginning quarters of the year, that forecasts from the present sources widely available may have limited usefulness. This question, however, best can be answered through more comprehensive knowledge of the use of forecasted earnings by decision makers.

FOOTNOTES

[1]For a comprehensive treatment of previous research in this area, see Abdel-khalik and Thompson [1977-78].

[2]Since this process has been the subject of a growing amount of research, we will omit a detailed specification of the process. Interested readers are directed to Box and Jenkins [1970] or Nelson [1973].

[3]The F model differs from the model proposed by Foster in that the drift term is excluded based on evidence provided by Brown and Rozeff [1978] that this term is significant.

[4]The selection of an error metric assumes that a certain utility function is the most appropriate for evaluating alternative forecasting sources. This selection is arbitrary since little is known about the utility function of the users of earnings forecasts. In addition, a more complete analysis would require specification of the loss function specific to the investment decision.

[5]The selection of the value of 3.0 as an indication of an outlier was based on a visual analysis of the frequency distribution of the absolute percentage forecast error metric. As noted in a subsequent discussion, only 54 (1.05%) of the 5000 total forecasts required this adjustment.

[6]An excellent description of the use of the orthogonal polynomial MANOVA on single factor repeated measure designs is provided by McCall and Appelbaum [1973]. Also see Finn [1974] and Morrison [1967] a rigorous development of the multivariate general linear model.

[7]In particular the error correlation matrix from the orthogonal polynomial design must be of type H as discussed by Huynh and Field [1970]. With respect to the present study, tests revealed this assumption to be strongly violated.

APPENDIX

Listing of Sample Firms

1. Abbott Laboratories
2. Allied Chemical
3. American Cyanamid
4. American Seating
5. American Smelting
6. Bethlehem Steel
7. Borg-Warner
8. Bucyrus-Erie
9. Clark Equipment
10. Consolidated Natural Gas
11. Cooper Industries
12. Cutler - Hammer
13. Dr. Pepper
14. Dupont
15. Eastman Kodak
16. Eaton Corporation
17. Federal - Mogul
18. Freeport Minerals Co.
19. General Electric
20. Gulf Oil
21. Hercules, Inc.
22. Hershey Foods
23. Ingersoll - Rand
24. International Business Machines
25. International Nickel Co.
26. Lamsas City Southern Industries
27. Lehigh - Portland
28. Mead Corporation
29. Merck and Company
30. Mohasco Corp.
31. Moore McCormack
32. Nabisco, Inc.
33. National Gypsum
34. National Steel
35. Northwest Airlines
36. Peoples Drug Stores
37. Pepsico, Inc.
38. Rohm and Haas
39. Safeway Stores
40. Scott Paper
41. Square D
42. Stewart - Warner
43. Texaco, Inc.
44. Trans World Airlines
45. Union Carbide
46. Union Oil (Cal.)
47. U.S. Tobacco
48. Westinghouse Electric
49. Weyerhaeuser, Inc.
50. Zenith Radio

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